Institute *of* **Physics**

Bulletin of
The Environmental Physics Group

Volume 4, No. 1, 1998

Editorial

Welcome to the first edition of the Bulletin for 1998. In addition to the providing you with details of our next AGM this issue contains a research article on a novel method for monitoring atmospheric pollution. The article demonstrates how physics can help in understanding the impact we have on the environment. As usual we have our items on meetings, funding sources, books and reports and the latest news and information. Please keep sending your research articles, personal views or any relevant issues that you wish to highlight through the Bulletin. The EPG will be organising an eventful year of meetings and visits and other activities suggested by the membership throughout this year. If there are any particular activities that you would like to see organised then please let us know. Finally we all would like to wish you a happy and peaceful New Year. Don't forget that copies of the Bulletin are also available on the World Wide Web, at the following URL:

`http://www.nerc-essc.ac.uk/~dwcp/Htmls/epg_top.html` .

David Pearson and Ranjeet S Sokhi (Editors).

The views expressed in this editorial are those of the editors, and do not necessarily reflect those of the Institute of Physics or of the Environmental Physics Group. All contacts, deadlines and dates in the Bulletin should be confirmed and not relied upon. ULRs (Internet addresses) are in some instances case-sensitive.

AGM of the Environmental Physics Group

The seventh Annual General Meeting of the Environmental Physics Group will be held on **Monday 16 March 1998** during the meeting ***Modelling the Environment***, the Group's contribution to the Institute of Physics Annual Congress*, 16 – 19 March, 1998 at the Brighton Centre. Nominations for Committee members or for Group Officers (Chairperson, Vice-Chairperson and Honorary Secretary) should be sent to the Honorary Secretary not later than seven days before the AGM. Nominations must be proposed by not less than two Members of the Group and should be accompanied by the written consent of the nominee.

Peter Hodgson (Honorary Secretary)

*For further information on the Physics Congress contact The Conference Department, IOP, 76 Portland Place, London W1N 4AA, Tel 0171 470 4800; fax 0171 470 4848.

Research Notes

A hand portable membrane inlet mass spectrometer for environmental analysis

A.J. White[1], F. Nuber[1,2]

1 : Kore Technology, Cambridge, UK
2 : University of Hertfordshire, Hatfield, UK

Environmental pollution monitoring may be performed using a variety of techniques including gas chromatography (GC), infra red (IR) spectroscopy and mass spectrometry (MS) [1]. Because MS yields information on the masses and fragmentation patterns of the compounds under study, it can be an extremely powerful tool for chemical analysis. These fragmentation patterns lead to characteristic spectra that are widely available in commercial data libraries. With the use of computer software, or by manual methods, library spectra can often be matched to the gathered spectra leading to unambiguous identification of the sample. Sample inlet systems for MS can range from direct inlet arrangements (e.g. a simple leak valve) to concentrators using trap-desorb or membrane concentration methods. The latter is a powerful method, as it allows relatively rapid measurements to be made [2], and is the technique used for concentration in the MS described in this paper, the T-CAT.

Portable environmental analysis instruments are of particular interest because of the time and cost savings. Traditionally, samples are gathered on-site and taken to a laboratory for analysis [1]. This is usually performed using MS, GC or GC-MS. The process can be time-consuming and expensive. In addition, the delay between sample collection and analysis can lead to inaccurate results as samples undergo physical and chemical changes. Aside from the on-site analysis application area, small cheap MS instruments could prove of value for screening operations where a large expensive MS would otherwise be required.

Field portable mass spectrometers and GC/ MS systems have been the subject of research by a number of groups [2],[3],[4]. The MS used are generally quadrupole devices. The vacuum pumps tend to be either mains powered or require a base station for rough pumping and maintaining the vacuum. Eliminating these requirements would be a clear advantage in a portable MS design.

Any portable device would ideally be small, lightweight and of low power consumption. Vacuum systems require pumps, and these are generally the limiting factor in power consumption. The portable MS design therefore needs a low power consumption ultra-high vacuum (UHV) pump. Mechanical pumps are unfeasible in this application, as are oil-based pumps. An obvious alternative choice is an ion pump. They do not require backing pumps or cooling, can operate in any orientation, require little servicing and are very robust.

The power consumption of an ion pump is pressure dependent (increasing approximately linearly), therefore low pressure operation is desirable. This has the added attraction of minimising contamination of the ion source due to build up of analytes. However, a low

pressure MS source means that the MS method must be as sensitive as possible. The parallel detection and therefore high sensitivity of time-of-flight (ToF) MS makes this technique the obvious choice for the portable device.

The simplest design of ToF MS uses an ion source and a detector in a vacuum chamber. Ions are generated and accelerated through an electric field. Because the ions all receive the same energy, their flight velocity is mass dependent. The ion detector output is used to generate an arrival time histogram which can be converted to a mass (actually mass to charge ratio) spectrum. The addition of ion optics [5] and an electrostatic reflector, or reflectron [6], allow for improved mass resolution by focusing the ion beam on its way to the detector.

Because a complete spectrum is generated each cycle (unlike e.g. quadrupole MS devices which are scanning spectrometers), efficient use of the sample is made, as no ions are deliberately discarded. This gives the spectrometer relatively high sensitivity. In the T-CAT a further improvement in sensitivity is gained by using an annular ion source [7] (see figure 1). The source has a filament which provides electrons at 70eV for ionisation. The annulus of ions created in this source is accelerated along the spectrometer flight tube by a pulsed electrode (0 to -400V, 10 ns fall time) and is converged by ion optical electrodes. A cylindrical reflectron [6] focuses the ion beam and directs it back along the flight tube, inside the outgoing ion packet. At the detector the ion annulus is of sufficiently small diameter to be detected by a standard discrete dynode detector. This converging annular ToF geometry (CAT) gives the transportable CAT (T-CAT) its name.

The ion arrival time histogram is generated by a custom designed time to digital converter (TDC). Pulses from the detector are amplified and passed to the TDC which builds the histogram with 2 ns resolution. This histogram is generated in hardware on the TDC card, and is then passed to a standard laptop PC. Data analysis and processing can then be performed using modified data processing software [10]. Reduced spectra consisting of a series of data points containing only the areas of the mass peaks on whole mass numbers can be generated from the raw mass spectra. Mixture analysis to fit standard library spectra [9] using a partial least squares algorithm [8] to the gathered spectrum can also be performed.

The T-CAT vacuum chamber is maintained at a base pressure of about 10^{-9} mbar and an analysis pressure of about 10^{-7} mbar by a 2 l/s ion pump and a non-evaporable getter (NEG) pump. The ion pump (and indeed all of the power supplies for the spectrometer) is battery powered. The getter pump is unpowered. Rough pumping is performed only on the new system and on the rare occasions after a vent to atmospheric pressure. The T-CAT operator therefore requires no knowledge of vacuum technology, and bulky valves are avoided, reducing the size of the analyser.

As mentioned above, the T-CAT uses a membrane inlet system [1],[11] to introduce sample gases into the analyser. The analyte stream flows over a silicone rubber sheet membrane. The membrane absorbs the analyte which diffuses through the membrane along a concentration gradient towards the mass spectrometer inlet. The concentration gradient is maintained by a pressure drop across the membrane. The membrane absorbs different compounds to different degrees, and the compounds diffuse at different rates. The combination of the absorption and

diffusion processes gives a permeation rate which is compound dependent. Generally, volatile organic compounds (VOCs) have high permeation rates compared with gases such as nitrogen and oxygen [11]. This leads to a concentration effect for VOCs in air which has been observed to be >2000 for some VOCs through a single silicone membrane [11].

The diffusion rate of compounds through the membrane can lead to slow response times for some compounds. To perform faster analyses, the membrane should be as thin as possible. However, if sampling directly from atmospheric pressure, to gain a suitably low leak rate for the T-CAT analyser chamber to remain at UHV, the membrane area would have to be extremely small (about 10 um in diameter for a 100um thick membrane, and therefore impractical). The solution in the T-CAT inlet system is to first allow the sample through a membrane into an intermediate low-pressure region. The low pressure is maintained by a proprietary low vacuum (LV) pump, capable of achieving a vacuum of < 1 mbar at a flow rate of 2 cc/sec. From here, the sample diffuses to a second membrane and then permeates into the analyser. The second membrane has a lower pressure difference across it, and can therefore be of sensible dimensions. This dual membrane arrangement has the added benefit of giving 2 stages of concentration, improving the sensitivity for many compounds.

The T-CAT is packaged in a 53x33x21 cm case, and weighs about 21 kg including the battery. Power consumption is about 40 W when analysing, and 1.5 W in standby mode. The battery life is about 3 hours in continuous analysis and about 3 days on standby, although usually the device would be stored with a mains connection to keep the battery fully charged. If the battery is exhausted, however, the NEG pump maintains the UHV.

Spectrometer performance

With the current design, the T-CAT analyser has achieved resolutions of >500. With alternative source arrangements, the CAT geometry has achieved resolutions of >1000. The dynamic range is dependent on the number of histogramming cycles, and is generally over 4 orders of magnitude.

The detection limit of the T-CAT is partly dependent on the concentration effect of the inlet system. In addition, interferences can occur where small peaks in the spectrum arising from a compound of interest overlap with peaks from other compounds, or background peaks. In some cases, small changes in spectral peaks due to interesting compounds are superimposed on large peaks from the matrix gas or other interfering compounds. As a result the detection limit will depend on the exact compounds present.

For a 10 minute experiment (5 minutes each for the blank and the sample), example detection limits are about 2.1 ppb for benzene, 2.3 ppb for toluene and 3 ppb for Xylene. These detection limits are more than adequate for the majority of environmental monitoring applications.

References

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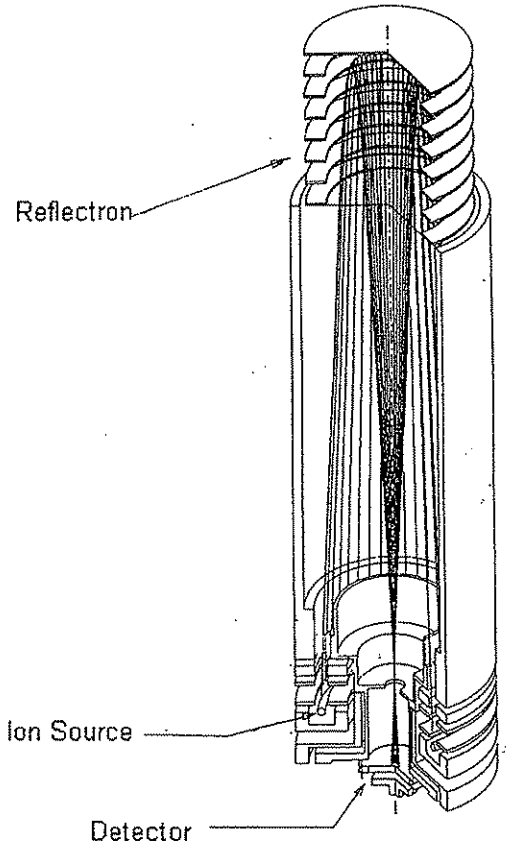

Figure 1 : CAT analyser geometry

Meetings, Conferences and Events

The Institute of Physics 6th Annual Congress
16-19 March 1998, The Brighton Centre

The 6th Annual Congress promises a varied programme which will include conferences, exhibition, plenary talks, public lectures, activities for schools, NEXUS student activities, and short courses. The following conference has been organised by the EPG:

Environmental Modelling: Modelling for Different Purposes, 16 March

This meeting will explore the various applications of modelling to help solve and understand environmental problems. For example, modelling can help to understand the fundamental physical processes that control dispersion of pollutants in our environment. It can also help to understand what impact we are having on the environment and how we can minimise it. Modelling is now increasingly used for long and short-term decision making by local and national organisations.

The preliminary programme includes:

Modelling methods and their scope
Gordon Laing (Ex Minister of Defence, Operational Analysis Establishment)
Modelling transport processes in soil: the effects of scale
Derek Rose (Agriculture and Environmental Science, University of Newcastle)
Long range transport models of sulphur and nitrogen species
David Lee (AEA Technology)
Modelling crop spraying processes
Peter Walklate (Silsoe Research Institute)
The response of a dynamic terrestrial carbon cycle model to imposed climate change
Chris Huntingford (Institute of Hydrology)
Assessing the impact of climate change on agriculture for site to regional scale in Europe
Ruth Butterfield (Environmental Change Unit, University of Oxford)

For further information please contact the Conference Department, Institute of Physics, 76 Portland Place, London, W1N 4AA, UK. Tel 0171 470 4800; fax 0171 470 4848.

First Announcement and Call for Papers: International Conference on Air Pollution Modelling and Simulation APMS'98, October 26-29, 1998, Paris

The following topics will be considered:
(1) Modelling of atmospheric chemical kinetics
(2) Multiphase and microphysical modelling
(3) Meteorology for the Regional (meso) Scale
(4) Meteorology for the Urban Scale, Urban Air Quality
(5) Emission models, input data
(6) Numerical simulation of transport and operator splitting
(7) Numerical simulation of atmospheric Chemical Kinetics
(8) High Performance Parallel Computations
(9) Data assimilation and sensitivity analysis

Registration form from: http://cermics.enpc.fr/manif/apms98/pres.html
or contact the Conference Secretariat (e-mail: symposia@inria.fr)
Relations Exterieures INRIA,
Conference APMS'98
INRIA, Domaine de Voluceau,
Rocquencourt, BP 105
78153 Le Chesnay Cedex, FRANCE
fax: +33.1.39.63.56.38
or contact the scientific secretary (e-mail: sportiss@cermics.enpc.fr).

Advanced Notice: The Second International Conference on Urban Air Quality - Measurement, Modelling and Management

Date: 3-5 March 1999
Venue: Technical University of Madrid (UPM), Spain
Organised by The Institute of Physics, UK in collaboration with The Technical University of Madrid (UPM), Spain and University of Hertfordshire, UK

Further information from Ranjeet S Sokhi, Tel: 01707 284520, Fax: 01707 285258
email: r.s.sokhi@herts.ac.uk

Research Funding News

Brite/Euram and Environment & Climate - Joint Call for Proposals for Research on Water [OJ No C 329 (31.10.1997), pp. 15-17]

The European Commission, DG XII, has published a call for proposals for research activities in the field of water under the Industrial and Materials Technologies (BRITE/EURAM) and Environment and Climate specific RTD programmes. All correspondence concerning this call should be sent, and proposals submitted to:

European Commission
DG XII - Science, research and development
Joint call for proposals on Environment and Water
200 rue de la Loi (SDME)
B-1049 Brussels
Fax 0032 2 296 3024

Proposals can also be delivered by hand to:
European Commission
DG XII, Directorate D
Square de Meeus 8
B-1040 Brussels

The text of the call may be found on the CORDIS World Wide Web server, at:

http://apollo.cordis.lu/cordis-cgi/srchidadb?CALLER=EDOCDEL&QF_EN_FNM=4BEA970906$
Closing date for submission of proposals: 2 February 1998 (12.00)

US EPA/NSF

The US Environmental Protection Agency and the US National Science Foundation are continuing to cooperate in considering proposals for research of interest to them. The new announcement for the Decision Making and Valuation for Environmental Policy program is available on the World Wide Web at

http://es.inel.gov/ncerqa/rfa/98valrfa.html

If you wish further information about this component of the EPA-NSF Partnership for Environmental Research, please contact any one of the following individuals:

Ms. Deborah Hanlon
hanlon.deborah@epamail.epa.gov
fax (202) 565-2447, voice (202) 564-6836

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Fax (703) 306-0485, voice (703) 306-1757

Progress on Framework V (Extracted from UKRHEEO Bulletin)

The current parliamentary draft is:

I. The 1st Thematic Programme, originally 'Unlocking the resources of the living world and ecosystem' has been renamed as 'Life sciences & genetic engineering', consisting of key actions in health & food, transmissible diseases and the cell factory (broken down into chemical & molecular biology mass, and central nervous system/age-related illnesses).

Environment & health is gone, the other 2 key actions moved to the newly proposed 'Environment & regional development' Thematic Programme.

II. The 2nd Thematic Programme on Information Society remains mostly unscathed, just minor changes to the 'Services for the citizen' key action.

III. The 3rd Thematic Programme, named by the Commission 'Promoting competitive and sustainable growth', has been renamed into 'Production and transport'. Changes to Key Actions are as follows:

* Key actions 1 and 2, 'Products, processes and organisation' and 'Sustainable mobility and intermodality' have been hit by minor changes;

* Key action 3 on 'aeronautics' has been extended to 'aeronautics and astronautics';

* Key action 4 on 'marine technologies' remains unchanged;

* Key action 5 on 'energy systems' has been moved to the new Thematic Programme on 'Energy';

* Key action 6 'City of tomorrow' has been moved to the new Thematic Programme on 'Environment and regional development'.

IV. The 4th Thematic Programme on 'Environment and regional development' (Parliament proposal) comprises key actions on 'sustainable development of rural and coastal areas' (changes), the 'City of tomorrow' (changes) and 'Sustainable management and quality of water' (changes).

V. The 5th Thematic Programme on 'Energy' (Parliament proposal) covers key actions on fossil fuels and renewable energies.

VI. Just when you think the Parliament actually comes up with better (i.e. shorter) names for the programmes, they propose to change the title of the 1st Horizontal Programme 'Confirming the international role of Community research' to the unspeakable 'Promotion of

cooperation with third countries and international organisation in the field of Community RTD and demonstration activities'. Changes in phrasing of the text.

VII. & VIII. The good news is that Parliament does not propose any changes to the other 2 Horizontal Programmes, 'Innovation and participation of SMEs' and 'Improving Human Potential', but the down side is they want to slash the budget of IHP by 250 MEcu (172 million pounds).

Further Information: http://www.cordis.lu/lux/home.html

Academic Research Collaboration: Austria / Britain

The British Council in Austria in collaboration with the Austrian Federal Ministry of Science and Transport invites applications from universities and research institutions for grants to develop Austro-British research projects. Preference will be given to projects with potential for EU funding. Grants will be offered towards the travel costs of exploratory visits to establish Joint research projects in the fields of environment; biotechnology; communications; transport engineering; medical and/or information technologies.

Further information and application forms:

Judith Portier
The British Council
Schenkenstrasse 4
A-1010 Vienna, Austria
Fax: 0043 1 533 26 16 85
Tel: 0043 1 533 26 16 74
E-mail: judith.portier@bc-vienna.at

NERC URGENT Programme - Call for Expressions of Interest

Second call for Outline Applications

The programme aims to stimulate the regeneration of the urban environment through greater understanding of natural processes. The programme is setting a new agenda for environmental and Earth Sciences. Its uniqueness lies in an attempt to understand the

complex series of interactions of environmental processes which are normally studied separately. Its objectives must ultimately be to produce predictive models and theories as a basis for management and policy. It should therefore not only be concerned with understanding the individual processes but also with the operation of the urban environment; the sources, fluxes and sinks of material and the energy with it; the time dependence of the system and the recoverability of degraded environments; and, sustainability of new modes of land use. ETSU, Harwell, have been appointed Programme Managers for this research programme on Urban Regeneration and the Environment. The programme will encourage consortia including local community interest with small manufacturing enterprises and local authorities.

URGENT Steering Committee Members:

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Dr JK Pearson, Private address
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Professor Sir Geoffrey Allen, FRS, FEng, FRSC (URGENT Steering Committee Chairman), Kobe Steel Ltd, Alton House, 174 High Holborn, LONDON, WC1V 7AA

Books, Reports and Publications

Air Pollution in the United Kingdom

Edited by C N Hewitt and G Davidson, Publisher: The Royal Society of Chemistry, 1997

The book provides an up-to-date overview of air pollution in the UK. It cover topics ranging from indoor air pollution, urban air pollution to global problems and the health effects of air pollution.

Digest of Environmental Statistics, No 19 and the Environment in your Pocket 1997

Publisher: Stationary Office.

The book covers a range of environmental protection statistics such as climate change, wildlife and air quality. Key facts are presented in a useful pocket version available free (Tel: 0181 691 9191).

Royal Commission on Environmental Pollution, 20th Report on Transport and the Environment - Developments since 1994

Publisher: Stationary Office.

The report warns of dangers of traffic growth and considers transport pattern changes and technological methods for reducing the impact.

News and Information

Environmental Physicists Wanted!

Mary Wood at the IOP's is looking for a pool of environmental physicists in various part of Great Britain and Ireland. The requirement is that you must be enthusiastic and willing to talk to young people within schools in their area.

An exhibition on Physics in Action is also being planned as part of the Physics Annual Congress (targeted at 12 and 13 year olds) and if anyone has suitable materials such as instruments or research results please contact:

Mary Wood, Coordinator (Education Support), IOP, Tel: 0171 470 4800, Email: mary.wood@iop.org

Air & Waste Management Association (A&WMA) comes to Europe!

This organisation, known as the Pan-European Section, is one of the geographic Sections of the Air & Waste Management Association.

The Purpose of this section will be to promote better understanding of the problems of air pollution control and waste management and related environmental concerns among government agencies, research personnel, educators, representatives of industry and the general public within the geographic area of the Section, and to work toward resolution of

these problems. It will also help to promote closer professional and personal relations among members of the Section and to further the mission and objectives of the Association.

Further information from:
Larry Cravey <71032.75@compuserve.com>

Air Quality Mailing List

A mailing list has been set up for those interested in air quality. The address for sending messages, questions, comments, technical information is:

air-quality@ic.ac.uk.

Any messages sent to this address will be re-directed to everyone who is a member of the list. However you must first subscribe to the list. To do this send an email to majordomo@ic.ac.uk and in the main body of the message (not the subject box) write:

subscribe <air-quality@ic.ac.uk>

There is a fuller set of instructions at
<http://www.ic.ac.uk/ccs/isg/userdocs/gendoc/gen/usrcard2.html>

Research assessment - electronic discussion group

The electronic discussion group on research assessment has gone live today on the internet at:.

http://www.cbcu.cam.ac.uk/hefce/rae.html

You can also access it from the HEFCE home page via the links to 'Assessment of Research' and 'What's New?'

This discussion group will act as a forum for staff in HEIs and others to contribute to and observe the debate around research assessment as it develops. Anyone can view or contribute to this discussion by logging onto the address given above.

Climate Change Brochure

All you ever wanted to know about climate change – certainties and uncertainties – is summaried in this brouchure which has been prepared by the Natural Environment Research Council (NERC). Copies can be obtained from:

NERC Planning and Communications Directorate, Tel: 01793 411623, Fax: 01793 411510, email: nerccomm@wpo.nerc.ac.uk

Internet Sites of Interest

UK Research and Higher Education European Office (UKRHEEO)

The UK Research and Higher Education European Office (UKRHEEO) promotes effective UK participation in European Community research and higher education programmes by alerting subscribing UK Higher Education Institutions (HEIs) and research laboratories to the funding opportunities available. The Office is in regular contact with European Commission officials and is well placed to provide information and guidance on EC schemes to individual researchers. UKRHEEO also plays an important role in the exchange of information between the UK research and higher education community and the EC.

UKRHEEO, which updates me on funding opportunities through their regular e-mail communiques and the monthly paper copy of the "Brussels Bulletin" which I circulate to you as departmental co-ordinators, have now developed their own web-site which can be accessed at the following URL:

http://www.ukrheeo.ac.uk/

EuRaTIN

The EuRaTIN network encompasses the Brussels based R&D liaison offices of Germany, the Netherlands, Sweden, Switzerland and the United Kingdom.

EuRaTIN compiles a compact overview of open and planned Calls for Proposals (i.e. invitations to submit proposals) within the 4th Framework Programme. It is updated every week.

EuRaTIN also offers a free service to look for research partners in Europe. In a questionnaire, you describe your scientific profile, your project and the profile of the requested partner(s).

The URL for this network is: http://www.euratin.net/index.html

Research Councils

Natural Environment Research Council (NERC): http://www.nerc.ac.uk
Engineering and Physical Sciences Research Councils: http://www.epsrc.ac.uk

London Street Maps on the Internet

http://www2.infoseek.com

Enter the address and ignore State and Zip Code to get your street map.

Other Useful Web Pages

RSS97: Observations and Interactions.
http://www.rdg.ac.uk/AcaDepts/sg/Geog/pages/rss97/rss97.html

Paul Mather's GIS, Geography, Remote Sensing, Climate, etc. list.
http://www.geog.nottingham.ac.uk/~mather/useful_links.html

The Department of the Environment.
http://www.open.gov.uk/doe/epsim

EUREKA! Promoting market-oriented R&D across Europe.
http://eureka.belspo.be/

The Environmental Change Network.
http://www.nmw.ac.uk/ecn/

European Science Foundation
http://www.esf.org/

The Committee of the EPG

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Dr Quintin Rayer	LaGuelle, Guellef Road, St Peter Port, The Channel Islands
Dr Neil Roberts	Magnetic Resonance Research Centre, University of Liverpool, Liverpool, L69 3BX. Tel: 0151 7945629, Fax: (0151) 7945635.
Dr John B Stewart	34 Twyford Avenue, Southampton, SO15 5NP
Ms Alexandra Wilson	Research and Development, Ove Arup & Partners, 13 Fitzroy Street, London, W1P 6BQ. Tel: 0171 4653045, Fax: 0171 4653669, Email: alexandra.wilson@arup.com .